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an invited talk

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Predicting the Hardness of Glass Surfaces

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High-strength, high-hardness glasses are currently one of the most important research areas in the glass community. However, a theoretical prediction of glass hardness has hitherto been impossible. Here, we extend the temperature-dependent constraint theory to quantitatively predict hardness of glasses, taking the ternary soda-lime-borate glassy system as an example. The advantage of applying constraint theory is that the key physics governing glass hardness can be treated analytically without the need for molecular dynamics or other complicated numerical solutions. By comparison of modeling results with experimental data, we reveal that hardness is governed by the number of network constraints at room temperature and that a critical number of constraints is required for a material to display mechanical resistance. Furthermore, we have modified the surface compositions of the borate glasses and show that the resulting change in hardness can be predicted by considering the number of constraints in the modified surface layer.